

CLAIMS

The invention is Claimed as follows:

1. A fluid heater for heating a medical fluid, comprising:
5 a radiant heater that emits energy in a direction towards the fluid;
a secondary heater that emits energy in a direction towards the fluid; and
a controller that causes at least one of the infrared heater and the secondary
heater to maintain a desired temperature of the fluid.
- 10 2. The fluid heater according to Claim 1, wherein the controller causes at
both the infrared heater and the secondary heater to maintain the desired temperature
of the fluid.
- 15 3. The fluid heater according to Claim 1, wherein the secondary heater is a
plate heater.
4. The fluid heater according to Claim 1, wherein the radiant heater
includes an infrared reflector that directs the energy towards the fluid.
- 20 5. The fluid heater according to Claim 1, further comprising at least one
transmissive material disposed between the radiant heater and the fluid.
6. The fluid heater according to Claim 1, wherein the secondary heater is
positioned fluidly upstream of the infrared heater.
- 25 7. The fluid heater according to Claim 1, wherein the radiant heater emits
a type of energy selected from the group consisting of: infrared, microwave, laser,
ultraviolet, gamma, ultrasonic, radio frequency, inductive energy and combinations
thereof.

8. A device for in-line heating of fluids flowing through a disposable dialysis unit, the device comprising:

an infrared heater having an infrared emitter positioned in a housing, the housing defining an opening facing the disposable unit when the infrared heater is in use, the infrared heater having an infrared transmissive material covering the opening, and the infrared heater having an infrared reflector positioned relative to the infrared emitter such that infrared energy from the infrared emitter is substantially directed toward the infrared transmissive material.

9. The device for in-line heating of fluids according to Claim 8, further comprising a plate heater adjacent the disposable unit.

10. The device for in-line heating of fluids according to Claim 8, wherein the plate heater is positioned on an opposing side of the disposable unit from the infrared heater.

11. The device for in-line heating of fluids according to Claim 8, further comprising an infrared absorption material positioned on an opposing side of the infrared transmissive material from the infrared heater, wherein the infrared absorption material increases in temperature from absorbing the infrared energy and heats the fluid in the disposable unit.

12. The device for in-line heating of fluids according to Claim 8, further comprising an infrared reflective material positioned on an opposing side of the transmissive material from the infrared heater, wherein the infrared reflective material directs at least a portion of the infrared energy outside of the housing toward the fluid in the disposable unit.

13. A device for in-line heating of a fluid flowing through a disposable unit for dialysis treatment to a patient, the device comprising:

an infrared emitter so constructed and arranged to heat at least a portion of the fluid in the disposable unit;

a plate heater so constructed and arranged to heat at least a portion of the fluid in the disposable unit; and

a controller that causes at least one of the infrared emitter and the plate heater to achieve a desired fluid temperature.

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14. A fluid heating device for in-line heating of fluids flowing through a disposable cassette having at least one flexible membrane, the device comprising:

an infrared emitter having an infrared emission in a first direction;

10 an infrared transmissive material disposed between the infrared emitter and adjacent the at least one flexible membrane of the cassette; and

a plate heater positioned adjacent to the at least one flexible membrane of the cassette.

15 15. The fluid heating device according to Claim 14, wherein the infrared transmissive material and the plate heater are adjacent the same flexible membrane on one side of the cassette.

20 16. The fluid heating device according to Claim 14, wherein the infrared transmissive material and the plate heater are adjacent different flexible membranes on opposite sides of the cassette.

25 17. The fluid heating device of Claim 14, wherein the transmissive material is selected from the group consisting of: sapphire glass, optical glass, infrared glass, glass ceramics, borosilicates, aluminosilicates, fused silica (quartz), zinc sulphide, silicon, germanium, fluoride/bromide/chloride compounds and combinations thereof.

30 18. A dialysis fluid heater for heating fluid in a fluid container, comprising: a radiant energy heater that heats at least a first section of a fluid container, the radiant energy heater having a radiant energy emission in a direction towards the first section; and

a second heater that heats at least a second section of a fluid container, the second heater having a heat transfer emission towards the second section;

wherein the dialysis fluid in the container is heated by at least one of the radiant energy heater and the second heater when the dialysis fluid is moving through the container.

5 19. The dialysis fluid heater according to Claim 18, wherein the dialysis fluid traveling at least at about 125 ml/min can be heated from about 5°C to about 37°C.

10 20. The dialysis fluid heater according to Claim 18, wherein the second fluid container interface has a higher melting temperature than a temperature of the second heater.

15 21. The dialysis fluid heater according to Claim 18, wherein the first fluid container interface abuts a passage way in the container having a different volume than a passage abutting the second fluid container interface.

22. The dialysis fluid heater according to Claim 18, wherein the second fluid container interface abuts a baffled pathway in the container for the dialysis fluid.

20 23. A dialysis fluid heater for heating dialysis fluid in a fluid container, comprising:

 a first heater; and

 a second heater cooperating with the first heater to heat the dialysis fluid;

25 wherein the first and second heaters heat at least about 2 liters of the dialysis fluid from about 10°C to about 37°C in about 13 minutes.

24. The dialysis fluid heater of Claim 23, wherein the first and second heaters can achieve a desired fluid temperature within about plus/minus 0.5°C.

30 25. The dialysis fluid heater of Claim 23, wherein the first and second heaters are provided adjacent to a disposable cassette.

26. The dialysis fluid heater of Claim 23, wherein the first and second heaters are of a different type.

27. A dialysis system comprising:
5 a fluid flow path;
a radiant heater that heats at least a portion of a dialysis fluid traveling along the fluid flow path; and
a second heater that heats at least a portion of the dialysis fluid traveling along the fluid flow path.

10 28. The dialysis system of Claim 27, further comprising a controller that selectively energizes at least one of the radiant and second heaters to achieve a desired temperature for the dialysis fluid.

15 29. The dialysis system of Claim 27, wherein the radiant and second heaters are placed in a device that additionally acts to transfer the dialysis fluid along the fluid flow path.

20 30. An in-line fluid heating system for use with a disposable fluid flow dialysis container, the in-line fluid heating system comprising:
a controller;
a radiant energy heater operatively connected to the controller, the radiant energy heater having a radiant energy emission towards the disposable fluid flow container in the dialysis system when operated by the controller;
25 a second heater operatively connected to the controller, the second heater having a heat energy emission towards the disposable fluid flow container in the dialysis system when operated by the controller; and
a temperature sensor coupled to the controller and having a signal indicative of a sensed temperature of a dialysis fluid.

30 31. The in-line fluid heating system according to Claim 30, wherein the fluid flow connector fluidly connects with at least one valve.

32. The in-line fluid heating system according to Claim 30, wherein the controller receives inputs from a plurality of temperature sensors that sense dialysis fluid temperatures.

33. The in-line fluid heating system according to Claim 30, wherein the first fluid flow container includes at least one temperature sensor that senses a dialysis fluid temperature.

34. The in-line fluid heating system according to Claim 30, wherein the fluid flow container is fluidly connected to at least one pump.

35. The in-line fluid heating system according to Claim 30, wherein the fluid flow container is fluidly connected to a bulk dialysis fluid container.

36. The in-line fluid heating system according to Claim 30, wherein the fluid flow container fluidly connects to a catheter disposed within a dialysis patient.

37. A method of heating dialysis fluid, comprising the steps of:
flowing the dialysis fluid through a disposable fluid conduit;
applying energy from a 2-dimensional heat energy source to the dialysis fluid in the disposable fluid conduit; and
applying energy from a 3-dimensional heat energy source to the dialysis fluid in the disposable fluid conduit.

38. The method of heating dialysis fluid according to Claim 37, wherein applying energy from the 3-dimensional heat energy source includes employing at least one device that reflects or absorbs the 3-dimensional heat.

39. The method of heating dialysis fluid according to Claim 37, wherein applying energy from the 3-dimensional heat energy source includes cooling the 3-dimensional heat source.

40. The method of heating dialysis fluid according to Claim 37, further comprising the step of controlling operation of the 3-dimensional heat energy source and the 2-dimensional heat energy source with a controller such that a selected one or both of the 3-dimensional and 2-dimensional heat energy sources heat the dialysis fluid.

41. The method of heating dialysis fluid according to Claim 37, wherein the step of flowing the dialysis fluid further comprises flowing the dialysis fluid past the 2-dimensional heat energy source and subsequently flowing the dialysis fluid past the 3-dimensional heat energy source.

42. The method of heating dialysis fluid according to Claim 37, wherein the 3-dimensional heat energy source is a radiant heater.

43. A method of in-line heating of dialysis fluid, comprising the steps of:
flowing the dialysis fluid through a disposable fluid conduit;
heating the dialysis fluid with a plate heater as the dialysis fluid in the disposable fluid conduit flows past the plate heater; and
heating the dialysis fluid with an infrared heater as the dialysis fluid in the disposable fluid conduit flows past the infrared heater.

44. The method of in-line heating of dialysis fluid according to Claim 43, wherein flowing the dialysis fluid includes continuously flowing the dialysis fluid.

45. The method of in-line heating of dialysis fluid according to Claim 43, wherein the steps of heating the dialysis fluid with an infrared heater and heating the dialysis fluid with a plate heater include heating a same portion of the dialysis fluid.

46. A method of providing dialysis to a patient needing same, comprising the steps of:
heating a dialysis fluid with a radiant heater and a second heater; and

passing the heated fluid into a portion of a patient.

47. The method of Claim 46, wherein the portion includes a peritoneal cavity of the patient.

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48. A method of providing continuous flow peritoneal dialysis to a patient, comprising the steps of:

heating a dialysis fluid with a radiant heater and a second heater;

passing the heated fluid into a portion of a patient; and

10 recirculating the fluid from the patient and cleaning the fluid.

49. The method of Claim 48, which further comprises reheating the recirculated fluid if necessary with at least one of the radiant heater and a second heater.

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50. A method of providing dialysis to a patient, comprising the steps of:

heating a dialysis fluid with a radiant heater and a second heater; and

infusing the heated fluid into a sleeping patient.

51. The method of Claim 50, which includes infusing the heated fluid into the patient at nighttime.

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52. The method of Claim 50, which includes heating the fluid while the patient is sleeping.